AF/$

Docket No.: 49959-039

PATENT

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**
**BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**

| | | |
|---|---|---|
| In re Application of | : | Customer Number: 20277 |
| Ariel BEN-PORATH | : | Confirmation Number: 4880 |
| Application No.: 09/334,049 | : | Tech Center Art Unit: 2623 |
| Filed: June 15, 1999 | : | Examiner: Vikkram Ball |

For: HYBRID INVARIANT ADAPTIVE AUTOMATIC DEFECT CLASSIFICATION

**TRANSMITTAL OF APPEAL BRIEF**

Mail Stop Appeal Brief
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Submitted herewith in triplicate is Appellant(s) Appeal Brief in support of the Notice of Appeal filed November 24, 2004. Please charge the Appeal Brief fee of $500.00 to Deposit Account 500417.

Respectfully submitted,

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**Date: January 21, 2005**

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Docket No.: 49959-03[illegible] PATENT

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For: HYBRID INVARIANT ADAPTIVE AUTOMATIC DEFECT CLASSIFICATION

## APPEAL BRIEF

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

This Appeal Brief is submitted in support of the Notice of Appeal filed November 24, 2004.

## I. REAL PARTY IN INTEREST

The real Party In Interest is Applied Materials, Inc.

## II. RELATED APPEALS AND INTERFERENCES

Appellants are unaware of any related appeals and interferences.



## III. STATUS OF CLAIMS

Claims 1-30 are pending in the application. It is from the rejection of claims 1-30 that this Appeal is taken.

## IV. STATUS OF AMENDMENTS

There are no outstanding amendments.

## V. SUMMARY OF INVENTION

The thrust of the present invention is directed to a method and apparatus for automatically classifying a defect on the surface of a semiconductor wafer into one of a plurality of predetermined classes after inspection with, for example, a scanning electron microscope (SEM) (see Application at page 7, lines 12-16). Specifically, the present invention employs a rule-based core classifier for fast initial classification of defects into a predetermined number of core classes, the core classifier being able to work during start-up and ramp-up of a production line because it does not require examples of defects (see Application page 7, lines 16-20). It also uses non rule-based specific adaptive classifiers (i.e., "classic classifiers"), each associated with only a small number of the core classes (e.g., with only one or two core classes), trained by the user with sample defect images, in parallel with the core classifier for sub-classification within a core class (Application at page 7, line 28 to page 8, line 5).

The present invention further employs a full classifier (also based on sample defect images), but only on a limited basis for special types of defects that do not fit in to the core classification scheme (Application at page 7, lines 25-27; page 8, lines 27-29). Thus, as the fabrication process matures and the types of defects of interest become more diverse, the specific adaptive and full classifiers can be trained as needed to perform more detailed defect classification (Application at page 8, lines 29-32). The present invention thereby utilizes the best attributes of three different types of classifiers to perform defect classification more quickly and reliably than prior art methodologies, enabling ready identification of processes causing defects,

and further enabling early corrective action to be taken (Application at page 7, lines 5-11; page 8, lines 20-22).

## VI. ISSUES

A. Whether claims 1, 3-5, 10, 12-14, 19, 22-26 and 30 are unpatentable under 35 U.S.C. §103(a) over U.S. Patent 6,047,083 (Mizuno).

B. Whether claims 2 and 11 are unpatentable under 35 U.S.C. § 103(a) over Mizuno in view of the article entitled "Automatic defect classification for semiconductor manufacturing", by Paul B. Chou et al., Machine Vision and Application, 1997, pp. 201-213 (Chou).

C. Whether claims 6 and 15 are unpatentable under 35 U.S.C. § 103(a) over Mizuno in view of the discussion at page 11, lines 7-30 of the present application.

D. Whether claims 7-9, 16-18, 20, 21, and 27-29 are unpatentable under 35 U.S.C. § 103(a) over Mizuno in view of U.S. Patent 5,172,421 (Nakamura).

## VII. GROUPING OF CLAIMS

The appealed claims 1, 3-5, 10, 12-14, 19, 22-26 and 30 stand or fall together. The appealed claims 2 and 11 stand or fall together. The appealed claims 6 and 15 stand or fall together. The appealed claims 7-9, 16-18, 20, 21, and 27-29 stand or fall together.

## VIII. THE ARGUMENT

### A. The Applied Prior Art

#### 1. Mizuno

The Mizuno reference relates to a semiconductor device defect classification system using a rule-based core classifier to classify defects into one of a predetermined number of core classes. Mizuno's inspection technique, as explained at col. 4:61 to col. 6:50 of Mizuno, includes the steps of comparing an SEM image of a defect with a reference image, then performing a boundary analysis to initially classify the defect. The boundary analysis is performed by following a set of rules programmed beforehand (see col. 5:30 to col. 6:3). Another boundary analysis is then conducted to further classify the defect by size (see col. 6:4:32). Absent is the claimed teaching of a specific adaptive classifier associated with the one core class and less than the predetermined number of core classes, and trained by the user with a set of sample defect images, to further classify the defect into a subclass.

#### 2. Chou

Chou relates to a rule-based classifier trained with sample images (see Chou, Abstract). Absent is the claimed teaching of a specific adaptive classifier associated with a particular core class, and the claimed combination of a core classifier and a specific adaptive classifier associated with a particular core class.

#### 3. Page 11, lines 11-30 of the present application

This passage of the present application describes the inventive specific adaptive classifiers, and contrasts specific adaptive classifiers to conventional full classifiers. This passage points out, *inter alia*, that conventional full classifiers typically utilize a set of 40-100 predicates (i.e., feature descriptors) of known defects, while an inventive specific adaptive

classifier typically utilizes only about 4-7 predicates. Absent is the claimed teaching of a plurality of specific adaptive classifiers, each associated with less than a predetermined number of core classes.

4. Nakamura

Nakamura relates to a rule-based classifier (see Nakamura, Abstract). Absent is the claimed teaching of a classifier associated with a particular core class, and the claimed combination of a core classifier and a specific adaptive classifier associated with a particular core class.

B. The Issues Addressed

1. The Examiner Did Not Establish a ***Prima Facie*** Case of Obviousness Under 35 U.S.C. § 103.

The initial burden of establishing a ***prima facie*** basis to deny patentability to a claimed invention under any statutory provision always rests upon the Examiner. ***In re Mayne***, 104 F.3d 1339, 41 USPQ2d 1451 (Fed.Cir. 1997); ***In re Deuel***, 51 F.3d 1552, 34 USPQ2d 1210 (Fed.Cir. 1995); ***In re Bell***, 991 F.2d 781, 26 USPQ2d 1529 (Fed.Cir. 1993; ***In re Oetiker***, 977 F.2d 1443, 24 USPQ2d 1443 (Fed.Cir. 1992). In rejecting a claim under 35 U.S.C. § 103, the Examiner is required to provide a factual basis to support the obviousness conclusion. ***In re Warner***, 379 F.2d 1011, 154 USPQ 173 (CCPA 1967); ***In re Lunsford***, 357 F.2d 385, 148 USPQ 721 (CCPA 1966); ***In re Freed***, 425 F.2d 785, 165 USPQ 570 (CCPA 1970). The Examiner is required to show that all the claim limitations are taught or suggested by the references. ***In re Royka***, 490 F.2d 981, 180 USPQ 580 (CCPA 1974); ***In re Wilson***, 424 F.2d 1382, 165 USPQ 494 (CCPA 1970). In addition, the Examiner is obliged to explain how and why one having ordinary skill in

the art would have been realistically motivated to combine the applied references to arrive at the claimed invention. ***In re Ochiai***, 71 F.3d 565, 37 USPQ2d 1127 (Fed.Cir 1991); ***In re Deuel***, ***supra***. In establishing the requisite motivation, it has been consistently held that the Examiner must show an objective teaching in the art that would have motivated one skilled in the art to modify the cited reference to yield the claimed invention. ***In re Jones***, 958 F.2d 347, 21 USPQ2d 1941 (Fed.Cir. 1992); ***In re Mills***, 16 USPQ2d 1430 (Fed.Cir. 1990); ***In re Fine***, 837 F.2d 1071, 5 USPQ2d 1596 (Fed.Cir. 1988).

As detailed below, none of the cited prior art references, alone or in combination, teaches or suggests an apparatus or a method that employs both a rule-based core classifier and a specific adaptive classifier associated with only a small number of the core classes that is a classic classifier trained by the user with a set of sample defect images, as required by independent claims 1, 10, 19 and 22. Since the Examiner has not shown that all the claim limitations are taught or suggested by the references, the Examiner has not established a ***prima facie*** basis to deny patentability to the claimed invention under 35 U.S.C. §103.

a. Claims 1, 3-5, 10, 12-14, 19, 22-26 and 30 are not rendered obvious under 35 U.S.C. §103(a) by Mizuno, because the Examiner has not shown that all the claim limitations are taught or suggested by the reference.

Regarding the obviousness rejection of independent claims 1, 10, 19 and 22 based on Mizuno, the primary Mizuno reference teaches the use of a rule-based core classifier to classify defects into one of a predetermined number of core classes. However, as admitted in the Final Office Action dated May 24, 2004 (Paper No. 16), Mizuno fails to teach or suggest using a specific adaptive classifier associated with the one core class and less than the predetermined number of core classes, and trained by the user with a set of sample defect images, to further

classify the defect into a subclass, as required by independent claims 1, 10, 19 and 22. Rather, Mizuno teaches using a second core classifier, based on the design rules of the device, for this function. In other words, Mizuno uses a rule-based classifier to initially classify defects, and also to subclassify the defects.

The Examiner contends that it would have been obvious to modify Mizuno's technique to add the claimed specific adaptive classifier to yield the claimed invention. This contention is supposedly supported by the fact that Mizuno teaches, at col. 5:15-20, subclassification of defects using a pattern design rule of the device which is stored by Mizuno's apparatus. The Final Office Action, at page 4, considers this to be the claimed classic classifier trained by the user, because the design rules are "recorded in to the apparatus prior to the inspection, i.e., in the training phase and that is done by the user interface, i.e., the user's involvement in training the classifier".

Appellant disagrees. The user's implementation of the design rules of a device under inspection would not be considered "training" of the classifier by a skilled artisan, under the plain meaning of the word "training" as used in the present application and in the cited prior art. Appellant submits that such an interpretation of the word "training" is unreasonably broad and has no support in the art.

Even assuming, ***arguendo***, that the user's involvement in setting up Mizuno's apparatus was considered to be training by the user (as the Examiner contends), Mizuno would nevertheless lack a teaching or suggestion of the *claimed* classic classifier, because it would not comprise a classifier trained by the user *with a set of sample defect images*, as required by the independent claims. Mizuno's classifier described at col. 5 is the epitome of a rule-based classifier, in that it classifies based on the design rules of the inspected semiconductor device. It needs no sample defect images to classify, since it uses the device's design rules.

It is pointed out in the Final Office Action that the claims must be given their broadest reasonable interpretation during examination. However, it is also required that all words in a claim be considered in assessing patentability. ***In re Wilson***, 424 F.2d 1382, 1385 (CCPA 1970). In other words, the Examiner cannot ignore claim language. It seems that in the Final Office Action, the limitation of independent claims 1, 10, 19 and 22 that the specific adaptive classifier is trained by the user *with a set of sample defect images* has been disregarded. This is not proper, since to establish ***prima facie*** obviousness of a claimed invention under 35 U.S.C. §103, all claim limitations must be taught or suggested by the cited prior art. ***In re Royka***, 490 F.2d 981 (CCPA 1974).

Since Mizuno does not teach or even suggest the claimed classic-style specific adaptive classifier associated with less than a predetermined number of core classes of defects and trained by the user with a set of sample defect images, it would not have been obvious to modify Mizuno combination to yield the invention of claims 1, 10, 19 or 22. In fact, insofar as it teaches the use of the design rules of the inspected semiconductor device to subclassify defects, Mizuno *teaches away* from the claimed specific adaptive classifier.

Thus, it would not have been obvious to modify Mizuno to yield the inventions of independent claims 1, 10, 19, and 22, because Mizuno does not teach or suggest the step of classifying a defect as being in one of an arbitrary number of variant subclasses using a specific adaptive classifier associated with less than a predetermined number of core classes that is a classic classifier trained by the user with a set of sample defect images, as required by independent claims 1 and 22; and does not disclose or suggest a specific adaptive classifier associated with less than a predetermined number of core classes for classifying the defect as being in one of an arbitrary number of variant subclasses that is a classic classifier trained by the

user with a set of sample defect images, as required by independent claims 10 and 19.

Consequently, claims 1, 10, 19 and 22 are patentable, as are claims 3-5, 12-14, 23-26, and 30, which depend from claims 1, 10, 19 and 22, respectively.

b. Claims 2 and 11 are not rendered obvious under 35 U.S.C. §103(a) by Mizuno in view of Chou, because the Examiner has not shown that all the claim limitations are taught or suggested by the references.

Regarding the obviousness rejection of claims 2 and 11 based on Mizuno and Chou, the Chou reference does not teach or suggest the claimed classic-style specific adaptive classifier, associated with less than a predetermined number of core classes of defects and trained by the user with a set of sample defect images, missing from Mizuno. Chou does not teach or suggest using non rule-based classifiers *associated with less than a predetermined number of core classes* to sub-classify defects, as claimed. Chou does not mention subclassification. Therefore, any combination of Mizuno and Chou, however made, would still be missing the claimed specific adaptive classifier, and it would not have been obvious to add the claimed specific adaptive classifier to any Mizuno/Chou combination.

Consequently, claims 2 and 11 are patentable.

c. Claims 6 and 15 are not rendered obvious under 35 U.S.C. § 103(a) by Mizuno in view of the discussion at page 11, lines 7-30 of the present application, because the Examiner has not shown that all the claim limitations are taught or suggested by the references.

Regarding the obviousness rejection of claims 6 and 15 based on Mizuno and page 11, lines 7-30 of the application, it is contended by the Examiner that the Applicant admits (at page 11, lines 7-30 of the present application) that a plurality of specific adaptive classifiers as claimed in claims 6 and 15, each associated with less than a predetermined number of core

classes, is in the prior art. This is not correct. There is no support at page 11 or anywhere else in the specification for the contention that Applicant considers the claimed plurality of specific adaptive classifiers to be in the prior art. In fact, the application is replete with statements as to the inventiveness of the claimed specific adaptive classifiers. See, for example, page 7, lines 28 et seq., distinguishing specific adaptive classifiers from prior art classic classifiers by the number of predicates used in each.

Since all the limitations of claims 6 and 15 are not found in the cited references, the rejection under § 103 should be withdrawn.

Consequently, claims 6 and 15 are patentable.

d. Claims 7-9, 16-18, 20-21 and 27-29 are not rendered obvious under 35 U.S.C. § 103(a) by Mizuno in view of Nakamura, because the Examiner has not shown that all the claim limitations are taught or suggested by the references.

Regarding the obviousness rejection of claims 7-9, 16-18, 20-21 and 27-29 based on the Mizuno and Nakamura references, Nakamura does not teach or suggest the recited specific adaptive classifier of independent claims 1, 10, 19 and 22 (from which claims 7-9, 16-18, 20-21 and 27-29 depend) missing from Mizuno. Nakamura teaches a rule-based classifier (see Nakamura, Abstract). Moreover, Nakamura does not teach a classifier associated with a particular core class, as claimed. Still further, Nakamura does not teach the claimed combination of a core classifier and a specific adaptive classifier associated with a particular core class. Therefore, any combination of Mizuno and Nakamura, however made, would still be missing the claimed specific adaptive classifier, and it would not have been obvious to add the claimed specific adaptive classifier to any Mizuno/Nakamura combination.

Consequently, claims 7-9, 16-18, 20-21 and 27-29 are patentable.

## IX. SUMMARY

The Examiner's rejections under 35 U.S.C. § 103 do not withstand scrutiny, in that the Examiner has not shown that all the claim limitations are taught or suggested by the references. Appellant, therefore, respectfully submits that the Examiner has not established a prima facie basis to deny patentability to the claimed invention under 35 U.S.C. § 103.

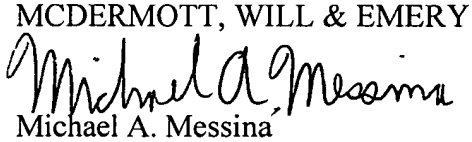
## X. PRAYER FOR RELIEF

In view of the foregoing arguments, Appellants respectfully solicit the Honorable Board to reverse the Examiner's rejection of claims 1-30 under 35 U.S.C. § 103.

To the extent necessary, a petition for an extension of time under 37 CFR 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 12-2237 and please credit any excess fees to such deposit account.

Respectfully submitted,

MCDERMOTT, WILL & EMERY



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## APPENDIX 1

1. A method of classifying a defect on the surface of an article, which method comprises:

imaging the surface to form a defect image;

classifying the defect as being in one of a predetermined number of core classes of defects using a rule-based core classifier; and

classifying the defect as being in one of an arbitrary number of variant subclasses using a specific adaptive classifier associated with the one core class and associated with less than the predetermined number of core classes, the specific adaptive classifier being a classic classifier trained by the user with a set of sample defect images.

2. The method according to claim 1, comprising classifying the defect as being in one of an arbitrary number of variant classes using a full classifier when the core classifier cannot classify the defect into one of the core classes.

3. The method according to claim 1, wherein the core classes of defects comprise a pattern defect and a particle defect.

4. The method according to claim 3, wherein the core classes of defects comprise a missing pattern on the surface, an extra pattern on the surface, a particle on the surface, a particle embedded in the surface, and microscratches on the surface.

5. The method according to claim 4, wherein the variant subclasses of defects comprise a particle of a predetermined size on the surface or embedded in the surface.

6. The method according to claim 1, comprising providing a plurality of specific adaptive classifiers, each being associated with less than the predetermined number of core classes.

7. The method according to claim 1, comprising performing a boundary analysis of the defect image, a topographical analysis of the defect image, or both to classify the defect into the one core class.

8. The method according to claim 7, comprising:

training the specific adaptive classifier to identify defects of the variant subclass based on an exemplary set of known predicates of defects of the variant subclass; and

analyzing predicates associated with the defect image, using the specific adaptive classifier, to classify the defect into one of the variant subclasses.

9. The method according to claim 8, comprising training the specific adaptive classifier using decision tree or multidimensional clustering techniques.

10. An apparatus for classifying a defect on the surface of an article, comprising:

an imager to produce an image of the defect; and

a processor comprising:

a rule-based core classifier for classifying the defect as being in one of a predetermined number of core classes of defects, and

a specific adaptive classifier associated with the one core class and associated with less than the predetermined number of core classes for classifying the defect as being in one of an arbitrary number of variant subclasses, the specific adaptive classifier being a classic classifier

trained by the user with a set of sample defect images.

11. The apparatus according to claim 10, wherein the processor further comprises a full classifier for classifying the defect as being in one of an arbitrary number of variant classes when the core classifier cannot classify the defect into one of the core classes.

12. The apparatus according to claim 10, wherein the core classes of defects comprise a pattern defect or a particle defect.

13. The apparatus according to claim 12, wherein the core classes of defects comprise a missing pattern on the surface, an extra pattern on the surface, a particle on the surface, a particle embedded in the surface, and microscratches on the surface.

14. The apparatus according to claim 13, wherein the variant subclasses of defects comprise a particle of a predetermined size on the surface or embedded in the surface.

15. The apparatus according to claim 10, comprising a plurality of specific adaptive classifiers, each being associated with less than the predetermined number of core classes.

16. The apparatus according to claim 10, wherein the processor is further configured to perform a boundary analysis of the defect image, a topographical analysis of the defect image, or both to classify the defect into the one core class.

17. The apparatus according to claim 16,

wherein the specific adaptive classifier is trainable to identify defects of the variant subclass based on an exemplary set of known predicates of defects of the variant subclass; and

wherein the specific adaptive classifier is for analyzing predicates associated with the defect image to classify the defect into one of the variant subclasses.

18. The method according to claim 17, wherein the specific adaptive classifier is trainable using decision tree or multidimensional clustering techniques.

19. A classic-style specific adaptive classifier, trained by the user with a set of sample defect images, for classifying a defect on the surface of an article as being in one of an arbitrary number of variant subclasses of a core defect class of a predetermined number of core classes, the specific adaptive classifier being associated with less than the predetermined number of core classes and responsive to a rule-based core classifier for classifying the defect as being in the core class.

20. The specific adaptive classifier of claim 19, wherein the specific adaptive classifier is trainable to identify defects of the variant subclass based on an exemplary set of known predicates of defects of the variant subclass; and

wherein the specific adaptive classifier is for analyzing predicates associated with an image of the defect to classify the defect into one of the variant subclasses.

21. The specific adaptive classifier of claim 20, wherein the specific adaptive classifier is trainable using decision tree or multidimensional clustering techniques.

22. A computer-readable medium bearing instructions for automatically classifying a defect on the surface of an article, said instructions, when executed, being arranged to cause one or more processors to perform the steps of:

imaging the surface to form a defect image;

classifying the defect as being in one of a predetermined number of core classes of defects based on a set of rules; and

classifying the defect as being in one of an arbitrary number of variant subclasses based on the classification of the defect as being in the one core class and being in less than the predetermined number of core classes, and based on training by the user with a set of sample defect images.

23. The computer-readable medium according to claim 22, wherein the instructions, when executed, are arranged to cause the one or more processors to perform the step of classifying the defect as being in one of an arbitrary number of variant classes when the one or more processors cannot classify the defect into one of the core classes.

24. The computer-readable medium according to claim 22, wherein the core classes of defects comprise a pattern defect and a particle defect.

25. The computer-readable medium according to claim 24, wherein the core classes of defects comprise a missing pattern on the surface, an extra pattern on the surface, a particle on the surface, a particle embedded in the surface, and microscratches on the surface.

26. The computer-readable medium according to claim 25, wherein the variant subclasses of defects comprise a particle of a predetermined size on the surface or embedded in the surface.

27. The computer-readable medium according to claim 22, wherein the instructions, when executed, are arranged to cause the one or more processors to perform a boundary analysis of the defect image, a topographical analysis of the defect image, or both to classify the defect into the one core class.

28. The computer-readable medium according to claim 26, wherein the instructions, when executed, are arranged to cause the one or more processors to perform the steps of:

learning to identify defects of the variant subclass based on an exemplary set of known predicates of defects of the variant subclass; and

analyzing predicates associated with the defect image to classify the defect into one of the variant subclasses.

29. The computer-readable medium according to claim 28, wherein the instructions, when executed, are arranged to cause the one or more processors to perform the learning step using decision tree or multidimensional clustering techniques.

30. The computer-readable medium according to claim 22, wherein the instructions, when executed, are arranged to cause the one or more processors to perform the step of imaging the surface with a scanning electron microscope.